PB-246 112

INSPECTION MANUAL FOR THE ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS: SEWAGE SLUDGE INCINERATORS

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PEDCo-Environmental Specialists,
Incorporated

Prepared for:

Environmental Protection Agency

February 1975

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

310121

PB 246 112

EPA 340/1-75-004
FEBRUARY 1975

Stationary Source Enforcement Series

INSPECTION MANUAL FOR ENFORCEMENT OF NEW SOURCE PERFORMANCE STANDARDS

SEWAGE SLUDGE INCINERATORS

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement
Office of General Enforcement
Washington, D.C. 20460

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.: EPA 340/1-75-004	2.
3. RECIPIENT'S ACCESSION NO.: PB 246 112	
4. TITLE AND SUBTITLE: Inspection Manual for the Enforcement of New Source Performance Standards: Sewage Sludge Incinerators	5. REPORT DATE: Issue: February 1975
	6. PERFORMING ORGANIZATION CODE:
7. AUTHOR(S): T. W. Devitt and N. J. Kulujian	8. PERFORMING ORGANIZATION REPORT NO.:
9. PERFORMING ORGANIZATION NAME AND ADDRESS: PEDCo-Environmental Specialists, Inc. Suite 13, Atkinson Square Cincinnati, Ohio 45246	10. PROGRAM ELEMENT NO.:
	11. CONTRACT/GRANT NO.: 68-02-1073
12. SPONSORING AGENCY NAME AND ADDRESS: Environmental Protection Agency Office of Air and Water Programs Research Triangle Park, North Carolina 27711	13. TYPE OF REPORT AND PERIOD COVERED: Final
	14. SPONSORING AGENCY CODE:

15. SUPPLEMENTARY NOTES: One of a series of NSPS Enforcement Inspection Manuals

16. ABSTRACT

This document presents guidelines to enable enforcement personnel to determine whether new or modified sewage sludge incinerators comply with New Source Performance Standards (NSPS). Key parameters identified during the performance test are used as a comparative base during subsequent inspections to determine the facility's compliance status. The sewage sludge incineration process, atmospheric emissions from these processes, and emission control methods are described. The inspection methods and types of records to be kept are discussed in detail.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Incinerators, sewage treatment Air pollution control Verification inspection Performance tests	New Source Performance Standards Enforcement Emission testing	13 B 14 D

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
Release unlimited	Unclassified	93
	20. SECURITY CLASS (This page)	22. PRICE
	Unclassified	$4.75

EPA Form 2220-1 (9-73)

U.S. GOVERNMENT PRINTING OFFICE 1975- 210 810 38

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SEWAGE SLUDGE INCINERATORS

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U. S. ENVIRONMENTAL PROTECTION AGENCY
Division of Stationary Source Enforcement
Washington, D. C.

January 1975

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ACKNOWLEDGMENT

This report was prepared by Mr. Norman J. Kulujian, under the direction of Mr. Timothy W. Devitt. Messrs. Arnold Stein and Parveen Amar of Pacific Environmental Sciences assisted in preparing the first three chapters. Project Officer for the Environmental Protection Agency was Mr. John Butler. The authors appreciate the contribution made to this study by Mr. Butler and other members of the Division of Stationary Source Enforcement.

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1.0 INTRODUCTION

Pursuant to Section 111 of the Clean Air Act, the Administrator of the U.S. Environmental Protection Agency (EPA) has promulgated particulate emission and opacity standards of performance for new and modified sewage sludge incinerators. As specified in 40 CFR, Part 60, as Amended by 39 F.R. 47, these standards apply to all incinerators which burn sludge produced by municipal wastewater treatment facilities. These standards were effective February 28, 1974, and apply to all sources whose construction or modification commenced after June 11, 1973.

Each state may develop a program for enforcing new source performance standards (NSPS) applicable to sources within its boundaries. If this program is adequate, EPA will delegate implementation and enforcement authority to the state for all affected sources with the exception of those owned by the U.S. Government. Coordination of activities between the state agency and EPA, both Regional Office and Division of Stationary Source Enforcement, is thus essential for effective operation of the NSPS program. To facilitate such state participation, EPA has established guidelines identifying the administrative procedures states should adopt to effectively implement and enforce the NSPS program.

The long-term success of the NSPS program depends largely upon the adoption of an effective plant inspection program. Primary functions of the inspection program are monitoring the NSPS performance tests and routine field surveillance. This manual provides guidelines for conducting such field inspections. However, the same basic inspection procedures presented in this manual should also be of use in enforcing emission regulations contained in state air quality implementation plans. Section 2.1 presents a survey of emission limitations in state implementation plans for the purpose of comparing them with NSPS.

2.0 SIP REQUIREMENTS AND NSPS

Standards of air pollution control performance for new and modified sewage treatment plants are included within the second group of stationary sources. The standards were promulgated as amendments into the General Provisions of 40 CFR 60 on March 8, 1974.

2.1 EXISTING SOURCES; STATE IMPLEMENTATION PLANS

Particulate emission standards applicable to existing sewage sludge incinerators vary from state to state. For example, New Jersey regulates sewage sludge incinerators via the incineration standard of 0.09 lb particulate/100 lbs refuse and a maximum opacity of 20 percent. Ohio and New York on the other hand specifically regulate emissions under the process source regulation. In New York emissions (E) are limited to $0.024\ P^{0.667}$ for sources with process weights (P) less than 50 tons/hr and 0.03 grains/ft^3 for sources over 50 tons/hr. Ohio limits emissions to $4.10\ P^{0.67}$ for P less than 30 tons/hr and $44.0\ P^{0.11} - 40$ for P larger than 30 tons/hr. Both New York and Ohio limit opacity to 20 percent. Most states treat sewage sludge as a process source with limits approximately those of Ohio and New York.

The applicable state regulations for incineration sources are tabulated in Table 2.1. The values, derived from Reference 1, apply to sewage sludge as well as municipal incinerations.

2.2 SUMMARY OF NSPS

The standards for new or modified sewage sludge incinerators are summarized below. A complete copy of the regulations plus revisions through November 1974 are presented in Appendix A.

2.2.1 Emission Standards

The exhaust gases from new or modified sewage sludge incinerators must not contain particulate matter in excess of 0.65 g/kg dry sludge input (1.30 lb/ton of sludge input) or exhibit an opacity of 20 percent of greater. A comparison of NSPS emission standards (0.065 lb/100 lb dry sludge

charged) to SIP regulations (Table 2.1) indicates the new source standards are more stringent than the majority of state codes. Particulate matter is defined as any finely divided liquid or solid matter other than uncombined water. Opacity standards do not apply to emissions during periods of start-up, shutdown and malfunction.

2.2.2 Performance Testing

Operation within the standards stated in Section 2.2.1 is to be confirmed by emission tests no later than 60 days after the maximum incineration rate has been achieved, but no longer than 180 days after initial start-up.

Responsibilities of the incinerator facility are listed below:

- Give a minimum of 30 days notification of scheduled tests
- Give a minimum of 30 days notice of anticipated start-up. EPA must be notified of the actual start-up date within 15 days after such date.
- Provide adequate sampling ports, safe sampling platforms, safe access to the sampling sites, and utilities for sampling and testing equipment.
- Perform emission tests and furnish a written report of test results to the Administrator.

Testing requirements are summarized in Table 2.2. The testing procedures are specified in 40 CFR 60. EPA personnel have the right to perform additional tests at any reasonable time.

Table 2.1 REGULATIONS APPLICABLE TO INCINERATION SOURCES

(lbs particulate / 100 lbs refuse charged)

State	CAPACITY, lb/hr								State	CAPACITY, lb/hr							
	<200	≥200	<2000	≥2000	<4000	≥4000	≥10,000	ALL		<200	≥200	<2000	≥2000	4000	≥4000	≥10,000	ALL
Alabama								0.20	Nebraska			0.19	0.09				
Alaska	0.29	0.19		0.09					Nevada								
Arizona								0.22	N. Hampshire	0.29	0.19						
Arkansas	0.29	0.19							New Jersey			0.19	0.09				
California									New Mexico								
Colorado	0.15	0.09							New York								0.50
Connecticut								0.08	N. Carolina	0.20			0.02				
Delaware			0.20	0.18	0.16				N. Dakota								
Dist. of Col.								0.03	Ohio	0.20		0.10					
Florida						0.08			Oklahoma								0.40
Georgia					0.10	0.08			Oregon	0.29	0.19						
Hawaii								0.20	Pennsylvania								0.09
Idaho								0.20	Rhode Island			0.15	0.08				
Illinois			0.09	0.08			0.05		S. Carolina								
Indiana			0.39	0.23					S. Dakota								0.20
Iowa								0.20	Tennessee			0.20	0.10				
Kansas	0.29	0.19					0.09		Texas								
Kentucky								0.19	Utah								
Louisiana								0.19	Vermont								0.10
Maine					0.19	0.08			Virginia								0.13
Maryland	0.29	0.19	0.09	0.03					Washington								0.09
Massachusetts								0.09	W. Virginia	0.41	0.27					0.13	
Michigan[a]									Wisconsin	0.17				0.11	0.08		
Minnesota	0.30	0.20		0.10					Wyoming								0.20
Mississippi								0.19	Samoa					0.20	0.10		
Missouri	0.29	0.19							Guam								0.20
Montana	0.29	0.19							Puerto Rico					0.40			0.20
									Virgin Islands	0.20	0.19						

[a] 0.30 lbs particulate per 1000 lbs flue gas.

Table 2.2 SUMMARY OF TEST METHODS FOR NEW AND MODIFIED SEWAGE SLUDGE INCINERATORS

Parameter	Sampling method	Remarks
Particulate	5	3 runs constitute a test. Sampling time range is 60 to 150 minutes per repetition. Minimum sampling rate shall be 0.53 dscfm.
Velocity, flow rate	1,2	
Gas analysis	3	
Opacity	9	Readings shall be taken in 5 percent increments for total duration of particulate tests.
Dry sludge charging rate	§60.154	Several deviations are required from referenced test method to determine dry sludge charging rate.

2.2.3 Monitoring Requirements

New source performance standards require no monitoring of emissions from sewage sludge incinerators. However, a flow measuring device must be installed to determine either the mass or volume of sludge charged to the incinerator. The flow measuring device must have an accuracy of ±5 percent over its operating range.

2.2.4 Recordkeeping and Reporting

The facility must maintain a copy of performance test results for a period of two years. Incinerator personnel must also submit a copy of the emission test results to the appropriate Federal, state, or local regulatory agency.

The occurrence and duration of unplanned start-ups, shutdowns, or malfunctions are to be reported quarterly on the 15th day following the end of each calendar quarter. The report must include causes of malfunctions and the corrective measures applied. Scheduled shutdowns and start-ups (e.g. nightly and weekend shutdowns) are not to be reported.

To facilitate future inspections the facility should also keep certain records as discussed in Section 4.4 although these are not required by the law.

REFERENCES FOR CHAPTER 2

1. Duncan. L.J. Analysis of Final State Implementation Plans - Rules and Regulations, The MITRE Corporation, Prepared for the Environmental Protection Agency under Contract No. 68-02-0248, July 1972.

3.0 PROCESS DESCRIPTION, ATMOSPHERIC EMISSIONS, AND EMISSION CONTROL METHODS

Although widely varying types of sewage sludge incinerators exist, only the multiple-hearth furnace discussed in Section 3.1 is used extensively. Other types include traveling-grate furnaces, rotary kiln furnaces, fluidized-bed units, wet-oxidation units, and atomized spray units; these incinerators are discussed in Reference 1. Atmospheric emissions and control methods for sludge incinerators are discussed in Sections 3.2 and 3.3.

3.1 PROCESS DESCRIPTION

The sludge incineration process involves three steps: preliminary dewatering, drying, and combustion. Figure 3.1 is a generalized schematic of a sludge treatment system. The dewatering operation reduces the moisture content of the sludge from its original 90-plus percent to about 30 to 50 percent. Vacuum filtration, pressure filtration, and centrifugation are some of the dewatering methods used.

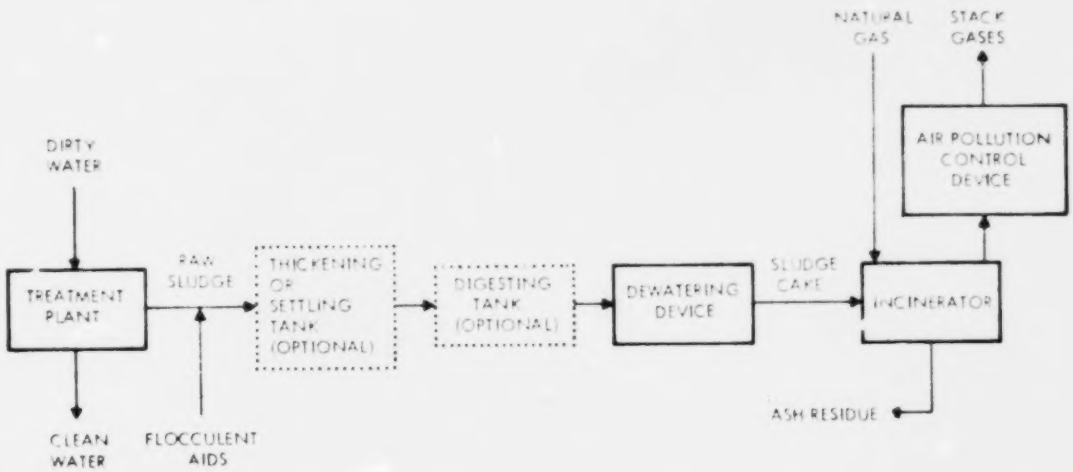


Figure 3.1 Sewage sludge treatment system.

Drying and combustion are successively accomplished in the multiple-hearth incinerator, shown in Figure 3.2. The multiple-hearth furnace consists of a circular steel shell surrounding a number of solid refractory hearths and a central rotating shaft to which rabble arms are attached. Complete drying and burnout requires that the incinerator have at least four hearths. Each hearth has an opening that allows sludge to be dropped to the next lower hearth. Many or all of the hearth stages have oil-or gas-fired burners to supply additional heat to the furnace. The rotating central shaft and rabble arms break up the large sludge particles to induce rapid and complete combustion.

Intermediate hearths provide a high-temperature zone (1600 to 1800°F), where combustion of the fixed carbon takes place. The bottom hearths of the furnace serve as a cooling zone (600°F), from which the exhaust gases rise to the top of the unit and then are ducted to a scrubber. A minimum of 50 percent excess air is required to burn the sludge properly. The fly ash slurry and ash from the incinerator are discharged through a hopper and transported to a landfill or lagoon.

As shown in Figure 3.2, a separate air system cools the central shaft. A forced-draft cooling air fan supplies air to the bottom of the shaft. The cooling air is heated as it passes upwards through the shaft. Most of the heated air is ducted to the incinerator for combustion; a small portion passes through a cooling air discharge duct, separate from the incinerator flue gas stack.

3.2 ATMOSPHERIC EMISSIONS

New or modified sewage sludge incinerators are subject to particulate and opacity standards. Although odors are major air contaminants, odor emissions are not covered by new source regulations. A well-operated sludge incinerator, employing proper housekeeping procedures, keep odors at a tolerable level.

NSPS pertain to the stack or stacks handling the combustion gases exiting from the incinerator and control device. The air used to cool the shaft and rabble arms, shown in Figure 3.2, is not directly involved in the combustion process. That portion of the cooling air that is allowed to escape to the atmosphere is excluded from the standards, and requires no testing or monitoring. If cooling gases are mixed with combustion gas, the steam plume will be minimized.

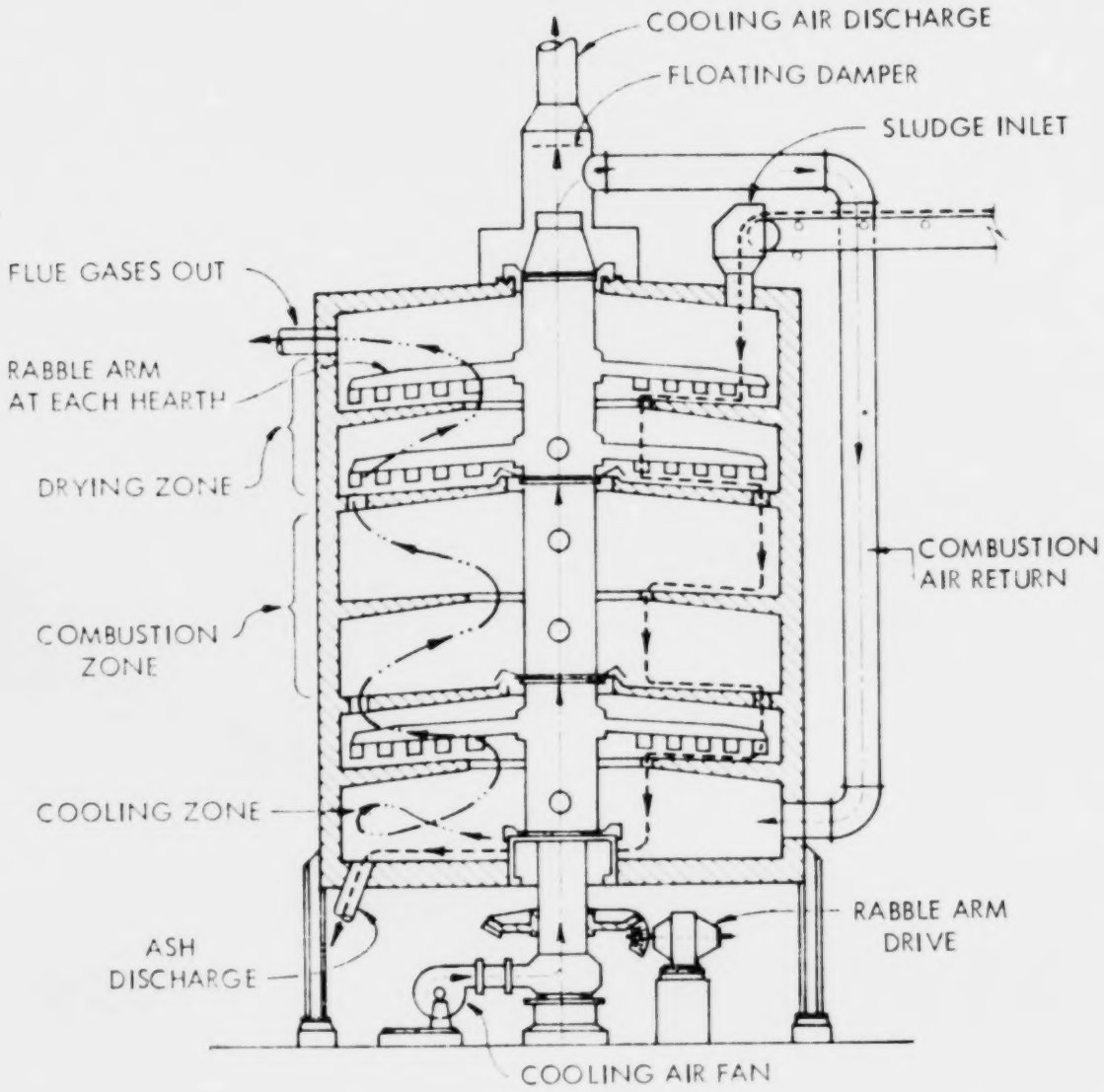


Figure 3.2 Typical section of a multiple-hearth sludge incinerator.

Particulate emissions into the atmosphere are almost entirely a function of scrubber efficiency and are only minimally affected by incinerator conditions, although emissions will increase if design temperatures are not maintained, or if excess sludge is fed into the incinerator. Uncontrolled multiple-hearth incinerator gases contain about 20 g/kg of dry sludge. Scrubbers need an efficiency of approximately 97 percent to meet the particulate standard of 0.65 g/kg. When the incinerator and control equipment are operating properly, stack opacities in most instances will be within allowable standards.

Continuously running sewage sludge incinerators require little or no auxiliary fuel to attain complete burnout of the sludge. Many incinerators are, however, shutdown during the weekend and must be restarted. To avoil excessive particulate emissions during start-up, the hearths of these units must be preheated with gas- or oil-fired heat before sludge is added.

3.3 EMISSION CONTROL METHODS

Water scrubbing is the most effective method for cleaning sludge incinerator exhaust gases. Wet scrubbers are relatively insensitive to particulate loadings and gas temperatures, and they collect the condensable portion of the emissions. Mechanical collectors may possibly be used on some existing modified units, but a mechanical collector cannot meet particulate standards unless it is augmented by a wet collection system.

Venturi, baffle plate, impingement, orifice, and cyclone-type scrubbers are potentially effective for controlling particulate emissions. Venturi and impingement types have successfully met emission standards.

In the venturi scrubber, the particulate-laden gas passes through a duct throat, where high velocities of 60 to 180 m/sec (200 to 600 fps) are attained at pressure drops of 50 to 75 cm (20 to 30 inches) water gage. Coarse water spray, injected into the duct throat at the rate of 19 to 38 liters per 28 cubic meters of gas (5 to 10 gallons per 1000 cubic feet of gas) atomizes and impacts with the particulate.

In impingement towers, the large particulates are removed by impingement on wet surfaces and contact with water spray in an area below the filter bed. The gas containing the remaining particulates then passes upward through a bed of spheres. These particulates are subjected to increased velocities in the interstices of the bed, which results in their impingement upon the surfaces of the spheres.

REFERENCES FOR CHAPTER 3

1. Burd, R.S. "A Study of Sludge Handling and Disposal," Federal Water Pollution Control Administration, NTIS Publication No. PB 179-514.

4.0 PROCESS, CONTROL DEVICE AND EMISSION MONITORING INSTRUMENTATION: RECORDS AND REPORTS

This section is designed to familiarize the inspector with emission-related instrumentation. The type, purpose, and location of each instrument are discussed; detailed theoretical principles of instrument operations are available from other literature sources.[1,2] The inspector must realize that gages may indicate faulty readings unless properly operated and calibrated.

4.1 PROCESS INSTRUMENTATION

Sewage sludge incinerators are equipped with a control panel of instruments that display the more important operating parameters associated with the facility. The instruments are provided mainly to aid the incinerator operator, but readings from two of these instruments, as discussed below, will help the new source inspector determine whether the sludge incinerator is complying with regulations.

Weigh Scale

Many incinerators use a readout scale gage on the control panel to monitor the quantity of sludge input to the incinerator. The amount of sludge burned during the performance test should be as great or greater than the amount that will be burned when the facility will be operated at representative conditions. The inspector should check with incinerator personnel to ensure that the dewatering device is working properly; variations in the dewatering operation can result in erroneous indications of the amount of sludge charged to the incinerator.

Furnace Temperature

The inspector must be able to determine incinerator temperatures because of their effect on uncontrolled emissions. Thermocouples are usually placed at each hearth position in the interior of the incinerator. The temperature of each hearth stage is read out either on separate gages or by a switching element connected to one gage. Many temperature

sensors are equipped with recorders that will enable the inspector to check temperature profiles. These data can be written on the daily charts and kept for comparison at the time of future inspection.

4.2 CONTROL DEVICE INSTRUMENTATION

The new source inspector's presence at the sewage sludge incinerator during the performance test will enable him to collect control device data which can be compared to values obtained during subsequent inspections. Such comparisons should reveal whether the source complies with particulate standards without further emission testing.

The inspector should check scrubber water flow rates from meters located either on the water line or control panel. Water pressure near the nozzles should also be recorded since abnormally low pressures might indicate broken nozzles (and hence poor atomization) and high pressure a plugged line or nozzles. Pressure drop across the control device should be recorded. The pressure drop is determined by manometer (water or oil) levels usually located on the scrubber, or in some instances, by indicating gages on the control panel.

4.3 EMISSION MONITORING INSTRUMENTATION

Opacity monitors are not required for sludge incinerators. Although opacity detectors do exist, they are rarely installed on sludge incinerators because the high moisture content of the exhaust gases can interfere with the opacity readings.

4.4 FACILITY RECORDKEEPING REQUIREMENTS

New or modified sludge incinerators are only required to keep records of unplanned non-continuous operation and malfunctions. However, the new source inspector should impress upon facility personnel the necessity of recording and filing additional data pertaining to emissions. The important parameters are tabulated in Table 4.1. Records of planned start-ups and shutdowns (e.g. weekends) are unnecessary. Records of malfunctions of the treatment plant are required only when incinerator performance is affected.

4.5 FACILITY REPORTING PROCEDURES

The NSPS specify that the facility operator must maintain certain records for a period of 2 years. Calibration and maintenance history must be kept in addition to a record of the parameters presented in Table 4.1.

Table 4.1 RECOMMENDED RECORDS TO BE KEPT BY SLUDGE INCINERATION FACILITIES PERSONNEL

Parameter	Units	Comments
Hearth temperature	°F	For recorder charts, date graph; for gages, keep hourly readings of minimum hearth temperature
Sludge burning rate	tons/day	Record daily throughput of dewatered sludge
Hours of operation	hours/day	Record daily hours of operation
Scrubber pressure drop	in. H_2O	Record scrubber pressure drop once per shift
Scrubber water flow rate	gpm	Record scrubber water flow rate once per hour
Start-ups, shutdowns, malfunctions or major changes in moisture content		Record any process malfunction that directly or indirectly increases particulate emissions or plume opacity
Performance testing		File report of test results

The operator must furnish written notification to EPA of the anticipated date of initial start-up, the actual date of start-up, and the date for conduct of the performance test. In addition, a written report of the performance test results must be submitted. It shall include collected particulate weights for each of the three repetitive tests, sample air volumes, times of tests, percents CO_2, sludge charging rates, and the calculated emission rate for each of the three tests. The suggested contents of stack test reports are presented in Appendix B.

The operator of the incinerator may also be required to provide other information to EPA or the state agency under separate regulations. This may include application for a permit to operate the new facility or information adequate to complete the semi-annual report on new emission sources as part of implementation plan requirements. Start-up, shutdown, and malfunction occurrences are to be reported on the 15th day following the end of each calendar quarter.

REFERENCES FOR CHAPTER 4

1. Considine, D.M. Process Instrumentation. Chemical Engineering. pp 84-113, January 29, 1968.

2. Meffert, D.P., M.M. McEven, and R.H. Gilbreath, Jr. Stack Testing and Monitoring. Pollution Engineering. 5:6: 25-33.

5.0 START-UP/MALFUNCTIONS/SHUTDOWN

5.1 START-UP

Because of their massiveness, incinerator hearths require a long time to absorb heat and reach a suitable temperature for sludge incineration. This presents no problem for continuously operating units, but many sludge facilities either shutdown at night or through the weekend.

It is preferable for incinerators shutting down for the night or weekend to have a temperature sensor set at a minimum hearth temperature. When the temperature inside the unit decreases to a certain level (such as 800°F for the middle hearth), the sensor actuates auxiliary fuel burners to maintain the desired temperature level.

Sludge incinerators that are partially heated require about 4 hours to reach a temperature suitable for burning sludge. Third-shift personnel usually turn on the oil or gas burners so that the incinerator will be ready for operation in the morning.

5.2 MALFUNCTIONS

Sludge incinerators malfunction less frequently than municipal refuse incinerators. The sludge characteristics and hearth loadings result in less wear and tear on sludge incinerators than occurs as a result of incineration of municipal wastes. However, several malfunctions have the potential to increase plume opacity and particulate emissions. These are discussed below:

- Dewatering operation

Increases in the vacuum, pressure, or centrifugal force can press too much water out of the filter "mat" or "cake". When the operator attempts to burn a constant amount of sludge, a higher percentage of sludge (less moisture) is incinerated. This results in an increase of particulate emissions from the incinerator, which may overload the scrubber.

° Auxiliary burners

Fuel oil ash can cake up the auxiliary fuel burners. When desired ignition temperatures are not reached, unburned particulate matter may enter the gas stream.

° Rabble arms

Unlike the central shaft, the rabble arm tips are not air-cooled. The rabble arm teeth, therefore, can be burned off. If arms without teeth are not replaced during scheduled maintenance shutdowns, the sludge does not receive adequate stoking and agitation.

° Scrubber

Emissions and opacity increase when typical scrubber malfunctions occur. These include plugging of the beds or venturi spray nozzles and loss of water supply.

5.3 SHUTDOWN

Emissions do not increase when the sludge incinerator is shutdown. Charging is discontinued, but the airflow and scrubber system are not shutdown until all the sludge has been dried and burned. Heat retained by the hearths and other interior parts keep temperatures at acceptable levels for the time needed to completely burn out the sludge after charging has been terminated.

6.0 PERFORMANCE TEST

A coordination meeting between the inspector and incinerator facility personnel is essential to avoid misunderstandings during the performance test. Section 6.1 covers the inspector's responsibilities before testing is started. Section 6.2 discusses the operating conditions under which the incinerator should be tested. Key items that should be observed during the test are discussed in Section 6.3. Section 6.4 describes the source test data that are necessary for the inspector to check to determine whether the test was properly run. The inspection checklist in Section 6.5 summarizes all process and test parameters to be recorded during the performance test.

6.1 PRETEST PROCEDURES

Although the new source standards stipulate exact procedures for compliance, facility personnel may misunderstand or not be aware of parts of the regulations. The inspector should therefore arrange a meeting with plant personnel to review the details of the test, as summarized in Section 2.2. The inspector should have copies of the performance standards available at the meeting.

The inspector must ensure that management understands that performance tests are valid only if performed while the facility is operating at representative performance. The inspector should also determine which testing firm will perform the tests and later contact the firm, if a representative of the firm is not in attendance at the meeting, to confirm that the tests will be run in accordance with procedures outlined in 40 CFR 60 and summarized in Table 2.2.

The inspector must also survey the ductwork for test port locations. If satisfactory sites are unavailable, he should suggest modifications (e.g. stack extensions, flow straightners) needed to obtain accurate test results. The location of a clean-up area should be agreed upon by all parties prior to the test date. During a tour of the incinerator, the inspector determines whether additional inspection personnel are required to monitor the process, sampling site, and exhaust stack.

6.2 PROCESS OPERATING CONDITIONS

A sludge incineration facility can comply with the new source standards only if operating conditions during the performance test conform with specific pre-established conditions. These conditions are established either during the pretest meeting or at some other date prior to the test.

Sludge Input - Prior to the performance tests the inspector should obtain from plant personnel the plant capacity and the predicted maximum sludge input. Plant personnel should take steps to ensure that avoidable circumstances will not curtail the supply of sludge at the time of the performance test since the plant must be operating at or above the maximum charging rate during the test. The sludge must also be representative of the typical sludge burned at the site. Screens and filters must properly function to produce a sludge of "typical" heating value. The dewatering operation should extract the correct amount of moisture from the sludge, since significant variations during the test will yield meaningless charging rate and emission values.

Incinerator Operating Conditions - The incinerator must operate in the usual manner during the particulate tests and opacity reading periods. Auxiliary fuel in excess of the amount burned during normal operation will invalidate the tests.

Scrubber Operating Conditions - Water flow rates and pressure drops across the scrubber must be within the normal ranges specified by the manufacturer and at the lowest values at which the facility anticipates operating for full-load charging to the incinerator.

Operation of the incinerator should be in equilibrium prior to testing. The incinerator should be running at the desired load for at least two hours before emission tests are started. Process data must be recorded during the stabilization period to ensure that the incinerator is in equilibrium during the performance runs.

6.3 PROCESS OBSERVATION

The process operating conditions discussed in Section 6.2 should be noted during the compliance test for future comparisons. These observations will provide a baseline for comparison with operating conditions during later inspections. Also, the observations may indicate reasons for excessive particulate emissions if the source fails to meet the NSPS.

The inspector must check several operating parameters during the course of the performance test. These include sludge charging rate, sludge moisture content, hearth temperatures, auxiliary fuel rates, and scrubber pressure drops and water flow rates.

Sludge Charging Rate - New sludge incinerators are equipped with a meter on the control panel to monitor sludge input to the incinerator. Since readings are instantaneous weight values, several readings are required during the tests to determine an average value.

Sludge Moisture Content - The inspector should observe the amount of water retained in the sludge after it passes through the dewatering operation. Moisture variations can affect emission concentrations and sludge charging values. During the performance tests the inspector should take a sludge sample and place it in a moisture proof container for subsequent analysis.

Hearth Temperatures - The maximum incinerator temperature on the middle hearths should be around 1600°F, and never below 1300°F. Temperatures normally run about 1000°F at the top hearths and 600°F at the bottom hearths. Although odors are not covered by the NSPS, the temperature of the combustion waste gases should be above 1000°F to minimize odors. All temperatures are monitored on the control panel.

Auxiliary Fuel Rate - The majority of incinerators do not require additional fuel to burn the sludge. If auxiliary fuel is added, however, the inspector must obtain fuel usage data from plant personnel. The source may not be in compliance if less fuel is used during future operation than was burned during the performance test.

Flue Gas Composition - The oxygen or CO_2 concentration in the flue gas reveals the amount of dilution or excess air that is mixed with the combustion gases. The majority of new sludge incinerators have an oxygen monitor located on the control panel. An oxygen range cannot be defined since each sludge incinerator has its own dilution air characteristics, but the value should not deviate more than 3 percent after the unit is in continuous operation.

6.4 EMISSION TEST OBSERVATIONS

Emission tests and opacity determinations are conducted by qualified emission testing personnel. The inspector is responsible for ensuring that all pertinent data are collected, that the field procedures and equipment meets CFR, and that the incinerator is run at representative performance during all sampling runs. A qualified technician or engineer reads

visible emissions during the three particulate runs. The approved visible emission data form appears in Appendix C.

The inspector's degree of surveillance of the stack sampling team depends on the confidence of the inspector and qualifications of the test personnel. Even if the inspector has complete trust in the sampling crew, the following tasks should always be performed:

- Record duct dimensions (both inside and outside) and locations of sample ports.
- Check the number of ports at the sampling site and examine the ducting for the nearest upstream and downstream obstructions. Ask the crew leader how many total points will be traversed and check with Figure 1.1 in 40 CFR 60 to determine whether the stream will be properly sampled.
- Note whether the crew runs a preliminary traverse, and if so, inquire what nozzle diameter is selected. (Isokinetic sampling is a function of nozzle size.)
- Check to ensure that the moisture content of the gas stream is determined by Method 4 or an equivalent method such as drying tubes or volumetric condensers; assumption of the moisture content is not allowed.
- Observe the leak test of the sampling train. The allowable leak rate is given in Method 5. Leakage results in lower concentrations than are actually present. Be next to the dry gas meter during the leak check, note whether the meter hand is moving. (The more the hand is moving, the greater the leakage). Leak checks must also be made if the train is disassembled during the run to change a filter or to replace any component.
- Ensure that a sludge sample is properly taken in non-porous jars. Although the test method states that a sample should be collected every hour, a 500 ml sample every 20 minutes is preferable. Remind the crew leader that 224 G. Method For Solid and Semi-Solid Samples, with 40 CFR 60 revisions (Appendix A), is the appropriate method for sludge mass determination.
- Record dry gas meter reading before and after test.
- Record average velocity head and temperatures in duct during test.

- If impingers are used during test, observe whether they are bubbling. If they are not, the sampling train is either plugged or disconnected from the pump.

- Check the cleaning procedure for the front half of the train. Careless removal of filters or cleaning of probes will result in lower calculated emissions. Look for broken glass from probes or connectors. Test is void if glass probe is broken during test. If glass connectors are broken in transport from sampling site to clean-up area, test is still valid. Be sure identification labels are properly attached to collection containers. The probe should be brushed and rinsed with acetone thoroughly to remove all particulates. The probe should be visually inspected after cleaning to ascertain that all particulates have been removed.

- Observe gas analysis procedure for determining CO_2. Technician should take at least three samples before averaging readings. Variations greater than 0.5 percent (grab sample) or 0.2 percent (integrated sample) indicate gas mixture was not thoroughly bubbled in reagents. Ask technician or crew leader when new reagents were added to apparatus.

- Check percent isokinetic.

- Inquire about the calibration history of the sludge weightometer or volume recorder. The flow measuring device is required to maintain an accuracy of ± 5 percent over its operating range.

6.5 PERFORMANCE TEST CHECKLIST

The inspector must observe incinerator operation and emission tests simultaneously to ensure that valid data are used in determining plant performance. The performance test checklist shown in Table 6.1 is based upon the observations described in Sections 6.2, 6.3, and 6.4.

The reasons for having the inspector observe the test and complete the inspection sheet are twofold. First, incinerator and control device parameters will serve as guidelines for future NSPS recordkeeping requirements; and second, the inspector's observation of a few major parameters ensures that the tests were properly conducted.

The emission testing firm is required to submit test reports to the facility and the control agency. Results from the testing firm must be carefully checked and compared with data from the inspector's form.

Table 6.1

NSPS INSPECTION CHECKLIST FOR SEWAGE SLUDGE INCINERATORS

DURING PERFORMANCE TEST

Facility Number _____

Facility Address _____

Name of Plant Contact _____

Source Code Number _____

Unit Identification (To be Tested) _____

Design Input Capacity _____tons/day

Initial Start-up Date _____

Test Date _____

A. FACILITY DATA

Type ☐Multiple Hearth ☐Other — No. of Hearths _____ Specify _____

Average Sludge Moisture Content Out of Dewaterer _____%

Control Device ☐Scrubber ☐Other — Specify Type _____ Specify _____

Operating Schedule _____hr/day _____days/wk _____wks/yr

Certification of Sludge Measuring Calibration Date _____

B. FACILITY INCINERATOR PARAMETERS

Data to Obtain During Performance Test[a]

Parameter	Clock Time				
Sludge Input, tons/hr or ft^3/min					
Hearth of Max. Temp. (No.)					
Maximum Hearth Temp., °F					
Auxiliary Fuel Rate, gal. or ft^3 per min.					
Scrubber Water Flow, gpm					
Scrubber Pressure Drop (Δin.H_2O)					

[a]Data should be recorded every 20 minutes.

Table 6.1 (continued)

NSPS INSPECTION CHECKLIST FOR SEWAGE SLUDGE INCINERATORS

DURING PERFORMANCE TEST

C. PRETEST DATA (OBTAIN FROM TEST TEAM FIELD LEADER)

Test Company _____

Field Leader _____

Duct Dimensions _____in. x _____in.; Area_____ft^2

Nearest Upstream Obstruction _____ft

Nearest Downstream Obstruction _____ft

No. of Sampling Ports _____

No. of Sampling Points _____

No. of Sampling Points Required
From 40 CFR 60 _____

D. PARTICULATE PERFORMANCE TEST

Test No. _____ Start Time _____ Finish Time _____

	Yes	No
Preliminary Traverse Run (Method 1) Chosen Nozzle Diameter _____in.		
Train Leak Check	☐	☐
Sludge Sample Taken	☐	☐
Opacity Readings Taken	☐	☐

Moisture Determination (Method 4)
Percent Moisture _____
ml Collected/Gas Volume _____ml _____ft^3
(or wet/dry bulb readings)

Combustion Gas Analysis O_2 _____%

CO_2 _____%

Dry Gas Meter Reading Before Test _____ft^3 at _____(time)

Dry Gas Meter Reading After Test _____ft^3 at _____(time)

Volume Sampled _____ft^3

Test Duration _____minutes

Average Meter Orifice Pressure Drop _____inches

Average Duct Temperature _____°F

Velocity Head at Sampling Point _____**inches H_2O**

Meter ΔH@* _____

Repetition Start Time _____

Repetition Finish Time _____

Table 6.1 (continued)

NSPS INSPECTION CHECKLIST FOR SEWAGE SLUDGE INCINERATORS

DURING PERFORMANCE TEST

E. CLEAN-UP PROCEDURE

Filter Condition	☐ Dry		☐ Wet
Probe Status	☐ Unbroken		☐ Broken
Glass Connectors	☐ Unbroken		☐ Broken
Clean-up Sample Spillage	☐ None	☐ Slight	☐ Major
Sample Bottle Identification	☐ Yes		☐ No
Acetone Blank Taken	☐ Yes		☐ No

REFERENCES FOR CHAPTER 6

1. Emission Testing Compliance Manual, PEDCo-Environmental Specialists, Inc., EPA Contract No. 68-02-0237, Task No. 19, August, 1974.

7.0 INSPECTION PROCEDURES

Periodic visits to a sludge incinerator facility by the inspector will enable him to determine the plant's emission control status. A comparison of operating parameters during the inspection with values taken at the time of the performance test will indicate whether emissions are within the new source standards. Inspections during visits following the performance test are discussed in Section 7.1; an inspection checklist is provided in Section 7.2. Section 7.3 describes follow-up procedures after completion of an inspection of the incinerator facility.

7.1 CONDUCT OF INSPECTIONS

The frequency of inspections is governed by each regulatory agency's policy. A quarterly inspection is recommended unless complaints dictate more frequent inspections.

Major emphasis during the inspection is placed upon visual observation of the stack, checking facility records and inspecting instrumentation. Emphasis is placed upon determining visual emissions since it is both an enforceable standard in its own right and indicative of control system operation. The inspector compares records of operating hours and collection or burning rates with the charging rate during the performance test. Control device and readings from facility instrumentation will give an indication of whether particulate emissions are higher or lower than during the performance test.

The procedures noted below should be followed in the order shown whenever possible. This format enables the inspector to first tour the plant and then monitor instruments under actual operating conditions. Any questionable areas can be investigated later by examining records and consulting with the sludge incinerator operator.

OUTSIDE OBSERVATIONS

- Note plume opacity. Follow established EPA procedures. An observation form is presented in Appendix C.

DEWATERING EQUIPMENT

- Check the sludge moisture content. Take a sample if the sludge appears wetter or drier than it was during the performance test.

INCINERATOR AND SCRUBBER

- Read values of operational parameters listed in Part B of the Inspection Checklist.
- Look in the incinerator peepholes at the rabble arms. Teeth should be churning the sludge residue.

RECORDS

- Review sludge charging rates since last inspection.
- Examine dated charts of temperatures and control device parameters. If unsatisfactory values occur repeatedly, ask plant personnel what corrective measures have or will be taken.

7.2 INSPECTION CHECKLIST

The inspection form in Table 7.1 is derived from the procedures described in the preceding section.

7.3 INSPECTION FOLLOW-UP PROCEDURES

The inspector's affiliation may be with a Federal, state, or local agency. Interagency communications are necessary to keep personnel aware of the status of new or modified sewage sludge incinerators.

Some inspectors may have responsibility for air pollutants in addition to those covered by the NSPS, such as odors and fugitive emissions. The inspector's supervisor or his agency is responsible for determining whether the additional pollutants are handled separately or in combination with those covered by the NSPS.

If the inspector has evidence to cite the facility, he should precisely state the reasons on the citation. A citation at this point can only be given for definite violations (e.g. excessive opacity, control equipment not operating) or failure to keep required records.

Table 7.1

NSPS INSPECTION CHECKLIST FOR SEWAGE SLUDGE INCINERATORS
AFTER PERFORMANCE TEST

Facility Name _____

Facility Address _____

Name of Plant Contact _____

Design Charge Rate _____ tons/day

Inspection Date _____

A. PRE-ENTRY OBSERVATIONS Time _____

Stack Plume: Use EPA Plume Reading Procedures

Opacity Regulation ☐ In Compliance
☐ Not in Compliance

B. OPERATIONAL PARAMETERS Time _____

Sludge Input	_____ lb/hr
Maximum Hearth Temp.	_____ °F
Auxiliary Fuel Rate	_____ ft^3 or gal/min
Exhaust Gas Monitor	_____ Opacity % Transmittance
Scrubber Water Flow Rate	_____ gpm
Scrubber Pressure Drop	_____ in. H_2O

C. EQUIPMENT CONDITION

	Satisfactory	Unsatisfactory
Dewatering Equipment	☐	☐
Rabble Arms	☐	☐

D. RECORDS

	Records Kept		Values	
	Yes	No	Satisfactory	Unsatisfactory
Sludge Input	☐	☐	☐	☐
Hearth Temperatures	☐	☐	☐	☐
Auxiliary Fuel Consumption	☐	☐	☐	☐
Scrubber Flow Rates	☐	☐	☐	☐
Scrubber Pressure Drop	☐	☐	☐	☐
Instrument Maintenance and Calibration	☐	☐	☐	☐
Malfunctions	☐	☐	☐	☐

The inspector should also compare data on the latest inspection forms with data on previous forms or with performance test data. Although the question of whether a source is in compliance cannot be determined without a source test, sufficient information will be available to indicate whether the facility may be generating excessive particulate emissions. A comparison format is given in Table 7.2.

Values repeatedly over (or under) those shown in Table 7.2 indicate possible violations of new source performance standards. The responsible official should be notified in writing with data showing reasons for the assumed violations. Corrective action can either be taken by the facility to return operating conditions to values during the accepted performance test or a new source test should be conducted under the conditions the facility now deems representative of their operation.

Table 7.2 PARAMETER COMPARISON TO DETERMINE COMPLIANCE STATUS

Parameter	Category[a]	Percent over / under values during emission test to justify stack test
Visible emissions	A	Over 20% is out of complaince
Records not kept	A	
Sludge moisture	B	-20
Sludge feed rate	A	+15
Hearth temperature	C	-30
Auxiliary fuel consumption	C	-30
Gas analyzers	C	±30
Scrubber water flow	B	±40
Scrubber pressure drop	B	-20

[a]A - Parameter value for which citation can be issued on site.

B - Parameter value that strongly indicates that emissions are out of compliance. Value out of indicated ranges is justification for emission test.

C - Parameter value cannot be directly used to justify emission test; value can be used to support conclusions.

APPENDIX A

STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

CODE OF FEDERAL REGULATIONS

(See 40 CFR 60 for complete sampling procedures)

Chapter 1 - Environmental Protection Agency

SUBCHAPTER C - AIR PROGRAMS

PART 60 - STANDARDS OF PERFORMANCE
FOR NEW STATIONARY SOURCES

Subpart A - General Provisions

§60.1 Applicability.

The provisions of this part apply to the owner or operator of any stationary source which contains an affected facility the construction or modification of which is commenced after the date of publication in this part of any standard (or, if earlier, the date of publication of any proposed standard) applicable to such facility.

§60.2 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them in the Act:

(a) "Act" means the Clean Air Act (42 U.S.C. 1857 et seq., as amended by Public Law 91-604, 84 Stat. 1676).

(b) "Administrator" means the Administrator of the Environmental Protection Agency or his authorized representative.

(c) "Standard" means a standard of performance proposed or promulgated under this part.

(d) "Stationary source" means any building, structure, facility, or installation which emits or may emit any air pollutant.

(e) "Affected facility" means, with reference to a stationary source, any apparatus to which a standard is applicable.

(f) "Owner or operator" means any person who owns, leases, operates, controls, or supervises an affected facility or a stationary source of which an affected facility is a part.

(g) "Construction" means fabrication, erection, or installation of an affected facility.

(h) "Modification" means any physical change in, or change in the method of operation of, an affected facility which increases the amount of any air pollutant (to which a standard applies) emitted by such facility or which results in the emission of any air pollutant (to which a standard applies) not previously emitted, except that:

(1) Routine maintenance, repair, and replacement shall not be considered physical changes, and

(2) The following shall not be considered a change in the method of operation:

(i) An increase in the production rate, if such increase does not exceed the operating design capacity of the affected facility;

(ii) An increase in hours of operation;

(iii) Use of an alternative fuel or raw material if, prior to the date any standard under this part becomes applicable to such facility, as provided by §60.1, the affected facility is designed to accomodate such alternative use.

(i) "Commenced" means, with respect to the definition of "new source" in section 111(a)(2) of the Act, that an owner or operator has undertaken a continuous program of construction or modification or that an owner or operator has entered into a contractual obligation to undertake and complete, within a reasonable time, a continuous program of construction or modification.

(j) "Opacity" means the degree to which emissions reduce the transmission of light and obscure the view of an object in the background.

(k) "Nitrogen oxides" means all oxides of nitrogen except nitrous oxide, as measured by test methods set forth in this part.

(l) "Standard conditions" means a temperature of 20°C (68°F) and a pressure of 760 mm of Hg (29.92 in. of Hg).

(m) "Proportional sampling" means sampling at a rate that produces a constant ratio of sampling rate to stack gas flow rate.

(n) "Isokinetic sampling" means sampling in which the linear velocity of the gas entering the sampling nozzle is equal to that of the undisturbed gas stream at the sample point.

(o) "Start-up" means the setting in operation of an affected facility for any purpose.

(p) "Shutdown" means the cessation of operation of an affected facility for any purpose.

(q) "Malfunction" means any sudden and unavoidable failure of air pollution control equipment or process equipment or of a process to operate in a normal or usual manner. Failures that are caused entirely or in part by poor maintenance, careless operation, or any other preventable upset condition or preventable equipment breakdown shall not be considered malfunctions.

(r) "Hourly period" means any 60 minute period commencing on the hour.

(s) "Reference method" means any method of sampling and analyzing for an air pollutant as described in Appendix A to this part.

(t) "Equivalent method" means any method of sampling and analyzing for an air pollutant which have been demonstrated to the Administrator's satisfaction to have a consistent and quantitatively known relationship to the reference methods, under specified conditions.

(u) "Alternative method" means any method of sampling and analyzing for an air pollutant which is not a reference or equivalent method but which has been demonstrated to the Administrator's satisfaction to, in specific cases, produce results adequate for his determination of compliance.

(v) "Particulate matter" means any finely divided solid or liquid material, other than uncombined water, as measured by Method 5 of Appendix A to this part or an equivalent or alternative method.

(w) "Run" means the net period of time during which an emission sample is collected. Unless otherwise specified, a run may be either intermittent or continuous within the limits of good engineering practice.

§60.4 Address.

All requests, applications, submittals, and other communications to the Administrator pursuant to this part shall be submitted in duplicate and addressed to the appropriate Regional Office of the Environmental Protection Agency, to the attention of the Director, Enforcement Division.

§60.5 Determination of construction or modification.

When requested to do so by an owner or operator, the Administrator will make a determination of whether actions taken or intended to be taken by such owner or operator constitute construction or modification or the commencement thereof within the meaning of this part.

§60.6 Review of plans.

(a) When requested to do so by an owner or operator, the Administrator will review plans for construction or modification for the purpose of providing technical advice to the owner or operator.

(b)(1) A separate request shall be submitted for each construction or modification project.

(2) Each request shall identify the location of such project, and be accompanied by technical information describing the proposed nature, size, design, and method of

operation of each affected facility involved in such project, including information on any equipment to be used for measuremen. or control of emissions.

(c) Neither a request for plans review nor advice furnished by the Administrator in response to such request shall (1) relieve an owner or operator of legal responsibility for compliance with any provision of this part or of any applicable State or local requirement, or (2) prevent the Administrator from implementing or enforcing any provision of this part or taking any other action authorized by the Act.

§60.7 Notification and record keeping.

(a) Any owner or operator subject to the provisions of this part shall furnish the Administrator written notification as follows:

(1) A notification of the anticipated date of initial start-up of an affected facility not more than 60 days or less than 30 days prior to such date.

(2) A notification of the actual date of initial start-up of an affected facility within 15 days after such date.

(b) Any owner or operator subject to the provisions of this part shall maintain for a period of 2 years a record of the occurrence and duration of any start-up, shutdown, or malfunction in operation of any affected facility.

(c) A written report of excess emissions as defined in applicable subparts shall be submitted to the Administrator by each owner or operator for each calendar quarter. The report shall include the magnitude of excess emissions as measured by the required monitoring equipment reduced to the units of the applicable standard, the date, and time of commencement and completion of each period of excess emissions. Periods of excess emissions due to start-up, shutdown, and malfunction shall be specifically identified. The nature and cause of any malfunction (if known), the corrective action taken, or preventive measures adopted shall be reported. Each quarterly report is due by the 30th day following the end of the calendar quarter. Reports are not required for any quarter unless there have been periods of excess emissions.

(d) Any owner or operator subject to the provisions of this part shall maintain a file of all measurements, including monitoring and performance testing measurements, and all other reports and records required by all applicable subparts. Any such instruments, reports and records shall be retained for at least 2 years following the date of such measurements, reports, and records.

§60.8 Performance tests.

(a) Within 60 days after achieving the maximum production rate at which the affected facility will be op-

erated, but not later than 180 days after initial start-up of such facility and at such other times as may be required by the Administrator under section 114 of the Act, the owner or operator of such facility shall conduct performance test(s) and furnish the Administrator with a written report of the results of such performance test(s).

(b) Performance tests shall be conducted and data reduced in accordance with the test methods and procedures contained in each applicable subpart unless the Administrator (1) specifies or approves, in specific cases, the use of a reference method with minor changes in methodology, (2) approves the use of an equivalent method, (3) approves the use of an alternative method the results of which he has determined to be adequate for indicating whether a specific source is in compliance, or (4) waives the requirement for performance tests because the owner or operator of a source has demonstrated by other means to the Administrator's satisfaction that the affected facility is in compliance with the standard. Nothing in this paragraph shall be construed to abrogate the Administrator's authority to require testing under section 114 of the Act.

(c) Performance tests shall be conducted under such conditions as the Administrator shall specify to the plant operator based on representative performance of the affected facility. The owner or operator shall make available to the Administrator such records as may be necessary to determine the conditions of the performance tests. Operations during periods of start-up, shutdown, and malfunction shall not constitute representative conditions of performance tests unless otherwise specified in the applicable standard.

(d) The owner and operator of an affected facility shall provide the Administrator 30 days prior notice of the performance test to afford the Administrator the opportunity to have an observer present.

(e) The owner or operator of an affected facility shall provide or cause to be provided, performance testing facilities as follows:

(1) Sampling ports adequate for test methods applicable to such facility.

(2) Safe sampling platform(s).

(3) Safe access to sampling platform(s).

(4) Utilities for sampling and testing equipment.

(f) Each performance test shall consist of three separate runs using the applicable test method. Each run shall be conducted for the time and under the conditions specified in the applicable standard. For the purpose of determining compliance with an applicable standard, the arithmetic means of results of the three runs shall apply. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplaceable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond the owner or operator's

control, compliance may, upon the Administrator's approval, be determined using the arithmetic mean of the results of the two other runs.

§60.9 Availability of information.

(a) Emission data provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public.

(b) Except as provided in paragraph (a) of this section, any records, reports, or information provided to, or otherwise obtained by, the Administrator in accordance with the provisions of this part shall be available to the public, except that (1) upon a showing satisfactorily to the Administrator by any person that such records, reports, or information, or particular part thereof (other than emission data), if made public, would divulge methods or processes entitled to protection as trade secrets of such person, the Administrator shall consider such records, reports, or information, or particular part thereof, confidential in accordance with the purposes of section 1905 of title 18 of the United States Code, except that such records, reports, or information, or particular part thereof, may be disclosed to other officers, employees, or authorized representatives of the United States concerned with carrying out the provisions of the Act or when relevant in any proceeding under the Act; and (2) information received by the Administrator solely for the purposes of §60.5 and §60.8 shall not be disclosed if it is so identified by the owner or operator as being a trade secret or commercial or financial information which such owner or operator considers confidential.

§60.10 State authority.

The provisions of this part shall not be construed in any manner to preclude any State or political subdivision thereof from:

(a) Adopting and enforcing any emission standard or limitation applicable to an affected facility, provided that such emission standard or limitation is not less stringent than the standard applicable to such facility.

(b) Requiring the owner or operator of an affected facility to obtain permits, licenses, or approvals prior to initiating construction, modification, or operation of such facility.

§60.11 Compliance with standards and maintenance requirements.

(a) Compliance with standards in this part, other than opacity standards, shall be determined only by performance tests established by §60.8.

(b) Compliance with opacity standards in this part shall be determined by conducting observations in accordance with Reference Method 9 in Appendix A of this part. Opacity readings of portions of plumes which contain condensed, uncombined water vapor shall not be used for purposes of determining compliance with opacity standards. The results of continuous monitoring by transmissometer which indicate that the opacity at the time visual observations were made was not in excess of the standard are probative but not conclusive evidence of the actual opacity of an emission, provided that the source shall meet the burden of proving that the instrument used meets (at the time of the alleged violation) Performance Specification I in Appendix B of this part, has been properly maintained and (at the time of the alleged violation) calibrated, and that the resulting data have not been tampered with in any way.

(c) The opacity standards set forth in this part shall apply at all times except during periods of start-up, shutdown, or malfunction, and as otherwise provided in the applicable standard.

(d) At all times, including periods of start-up, shutdown, and malfunction, owners and operators shall, to the extent practicable, maintain and operate any affected facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Administrator which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures, and inspection of the source.

(e)(1) An owner or operator of an affected facility may request the Administrator to determine opacity of emissions from the affected facility during the initial performance tests required by §60.8.

(2) Upon receipt from such owner or operator of the written report of the results of the performance tests required by §60.8, the Administrator will make a finding concerning compliance with opacity and other applicable standards. If the Administrator finds that an affected facility is in compliance with all applicable standards for which performance tests are conducted in accordance with §60.8 of this part but during the time such performance tests are being conducted fails to meet any applicable opacity standard, he shall notify the owner or operator and advise him that he may petition the Administrator within 10 days of receipt of notification to make appropriate adjustment to the opacity standard for the affected facility.

(3) The Administrator will grant such a petition upon a demonstration by the owner or operator that the affected facility and associated air pollution control equipment was operated and maintained in a manner to minimize the opacity of emissions during the performance tests; that the

performance tests were performed under the conditions established by the Administrator; and that the affected facility and associated air pollution control equipment were incapable of being adjusted or operated to meet the applicable opacity standard.

(4) The Administrator will establish an opacity standard for the affected facility meeting the above requirements at a level at wh ch the source will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source is meeting the mass or concentration emission standard. The Administrator will promulgate the new opacity standard in the Federal Register.

§60.12 Circumvention.

No owner or operator subject to the provisions of this part shall build, erect, install, or use any article, machine, equipment or process, the use of which conceals an emission which would otherwise constitute a violation of an applicable standard. Such concealment includes, but is not limited to, the use of gaseous diluents to achieve compliance with an opacity standard or with a standard which is based on the concentration of a pollutant in the gases discharged to the atmosphere.

Subpart O - Standards of Performance for Sewage Treatment Plants

§60.150 Applicability and designation of affected facility.

The affected facility to which the provisions of this subpart apply is each incinerator which burns the sludge produced by municipal sewage treatment facilities.

§60.151 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act and in subpart A of this part.

§60.152 Standard for particulate matter.

(a) On and after the date on which the performance test required to be conducted by §60.8 is completed, no owner or operator of any sewage sludge incinerator subject to the provisions of this subpart shall discharge or cause the discharge into the atmosphere of:

(1) Particulate matter at a rate in excess of 0.65 g/kg dry sludge input (1.30 lb/ton dry sludge input).

(2) Any gases which exhibit 20 percent opacity or greater. Where the presence of uncombined water is the only reason for failure to meet the requirements of this paragraph, such failure shall not be a violation of this section.

§60.153 Monitoring of operations.

(a) The owner or operator of any sludge incinerator subject to the provisions of this subpart shall:

(1) Install, calibrate, maintain, and operate a flow measuring device which can be used to determine either the mass or volume of sludge charged to the incinerator. The flow measuring device shall have an accuracy of ±5 percent over its operating range.

(2) Provide access to the sludge charged so that a well-mixed representative grab sample of the sludge can be obtained.

§60.154 Test Methods and Procedures

(a) The reference methods appended to this part, except as provided for in §60.8(b), shall be used to determine compliance with the standards prescribed in §60.152 as follows:

(1) Method 5 for concentration of particulate matter and associated moisture content,

(2) Method 1 for sample and velocity traverses,

(3) Method 2 for volumetric flow rate, and

(4) Method 3 for gas analysis.

(b) For Method 5, the sampling time for each run shall be at least 60 minutes and the sampling rate shall be at least 0.015 dscm/min (0.53 dscf/min), except that shorter sampling times, when necessitated by process variables or other factors, may be approved by the Administrator.

(c) Dry sludge charging rate shall be determined as follows:

(1) Determine the mass (S_M) or volume (S_V) of sludge charged to the incinerator during each run using a flow measuring device meeting the requirements of §60.153(a)(1). If total input during a run is measured by a flow measuring device, such readings shall be used. Otherwise, record the flow measuring device readings at 5-minute intervals during a run. Determine the quantity charged during each interval by averaging the flow rates at the beginning and end of the interval and then multiplying the average for each interval by the time for each interval. Then add the quantity for each interval to determine the total quantity charged during the entire run, (S_M) or (S_V).

(2) Collect samples of the sludge charged to the incinerator in non-porous collecting jars at the beginning of each run and at approximately 1-hour intervals thereafter until the test ends, and determine for each sample the dry sludge content (total solids residue) in accordance with "224 G. Method for Solid and Semisolid Samples," Standard Methods for the Examination of Water and Wastewater, Thirteenth Edition, American Public Health Association, Inc., New York, N.Y., 1971, pp. 539-41, except that:

(i) Evaporating dishes shall be ignited to at least 103°C rather than the 550°C specified in step 3(a)(1).

(ii) Determination of volatile residue, step 3(b) may be deleted.

(iii) The quantity of dry sludge per unit sludge charged shall be determined in terms of either R_{DV} (metric units: mg dry sludge/liter sludge charged or English units: lb/ft^3) or R_{DM} (metric units: mg dry sludge/mg sludge charged or English units: lb/lb).

(3) Determine the quantity of dry sludge per unit sludge charged in terms of either R_{DV} or R_{DM}.

(i) If the volume of sludge charged is used:

$$S_D = (60 \times 10^{-3}) \frac{R_{DV} S_V}{T} \text{ (Metric Units)}$$

or

$$S_D = (8.021) \frac{R_{DV} S_V}{T} \text{ (English Units)}$$

where:

S_D=average dry sludge charging rate during the run, kg/hr (English units: lb/hr).

R_{DV}=average quantity of dry sludge per unit volume of sludge charged to the incinerator, mg/l (English units: lb/ft^3).

S_V=sludge charged to the incinerator during the run, m^3 (English units: gal).

T=duration of run, min (English units: min).

60×10^{-3}=metric units conversion factor, 1-kg-min/m^3-mg-hr.

8.021=English units conversion factor, ft^2-min/gal-hr.

(ii) If the mass of sludge charged is used:

$$S_D = (50) \frac{R_{DM} S_M}{T} \text{ (Metric or English Units)}$$

where:

S_D=average dry sludge charging rate during the run, kg/hr (English units: lb/hr).

R_{DM}=average ratio of quantity of dry sludge to quantity of sludge charged to the incinerator, mg/mg (English units: lb/lb).

S_M=sludge charged during the run, kg (English units:lb).

T=duration of run, min (Metric or English units).

60=conversion factor, min/hr (Metric or English units).

(d) Particulate emission rate shall be determined by:

$$c^{aw} = c^{s} Q^{s} \text{ (Metric or English Units)}$$

where:

c^{aw}=particulate matter mass emissions, mg/hr (English units: lb/hr).

c^{s}=particulate matter concentration, mg/m^3 (English units: lb/dscf).

Q^{s}=volumetric stack gas flow rate, dscm/hr (English units: dscf/hr). Q^{s} and c^{s} shall be determined using Methods 2 and 5, respectively.

(e) Compliance with §60.152(a) shall be determined as follows:

$$C_{ds} = (10^{-3}) \frac{c^{aw}}{S_D} \text{ (Metric Units)}$$

or

$$C_{ds} = (2000) \frac{c^{aw}}{S_D} \text{ (English Units)}$$

where:

C_{ds}=particulate emission discharge, g/kg dry sludge (English units: lb/ton dry sludge).

10^{-3}=Metric conversion factor, g/mg.

2000=English conversion factor, lb/ton.

APPENDIX - TEST METHODS

Method 1 - Sample and Velocity Traverses For Stationary Sources

1. Principle and Applicability

1.1 Principle. A sampling site and the number of traverse points are selected to air in the extraction of a representative sample.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

2. Procedure

2.1 Selection of a sampling site and minimum number of traverse points.

2.1.1 Select a sampling site that is at least eight stack or duct diameters downstream and two diameters upstream from any flow disturbance such as a bend, expansion, contraction, or visible flame. For rectangular cross section, determine an equivalent diameter from the following equation:

$$\text{equivalent diameter} = 2\left(\frac{(\text{length})(\text{width})}{\text{length} + \text{width}}\right) \qquad \text{equation 1-1}$$

2.1.2 When the above sampling site criteria can be met, the minimum number of traverse points is twelve (12).

2.1.3 Some sampling situations render the above sampling site criteria impractical. When this is the case, choose a convenient sampling location and use Figure 1-1 to determine the minimum number of traverse points. Under no conditions should a sampling point be selected within 1 inch of the stack wall. To obtain the number of traverse points for stacks or ducts with a diameter less than 2 feet, multiply the number of points obtained from Figure 1-1 by 0.67.

2.1.4 To use Figure 1-1 first measure the distance from the chosen sampling location to the nearest upstream and downstream disturbances. Determine the corresponding number of traverse points for each distance from Figure 1-1.

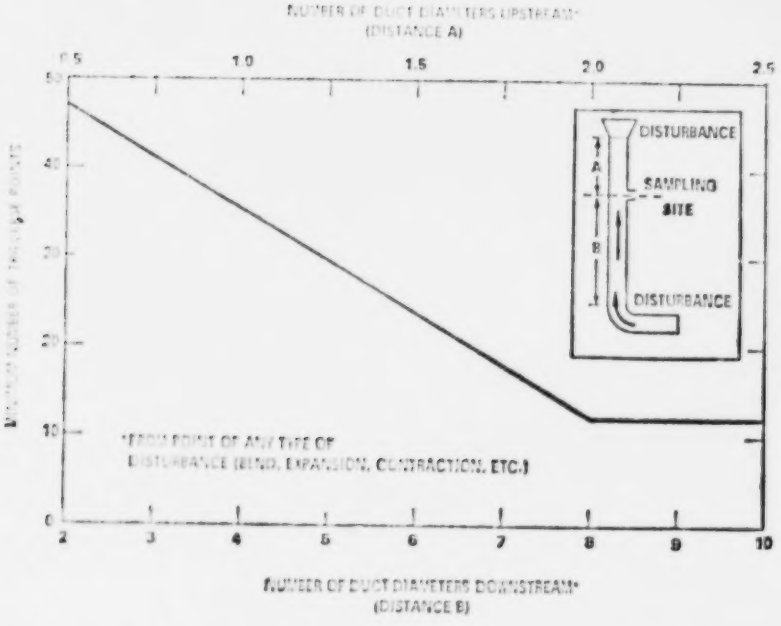


Figure 1-1. Minimum number of traverse points.

Select the higher of the two numbers of traverse points, or a greater value, such that for circular stacks the number is a multiple of 4, and for rectangular stacks the number follows the criteria of section 2.2.2.

2.2 Cross-sectional layout and location of traverse points.

2.2.1 For circular stacks locate the traverse points on at least two diameters according to Figure 1-2 and Table 1-1. The traverse axes shall divide the stack cross section into equal parts.

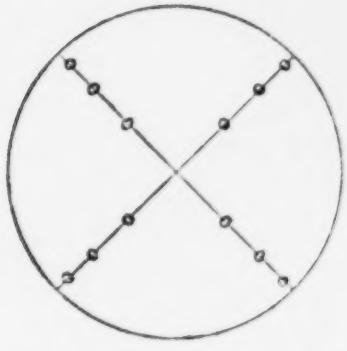


Figure 1-2. Cross section of circular stack divided into 12 equal areas, showing location of traverse points at centroid of each area.

Table 1-1. Location of traverse points in circular stacks (Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1
8				96.7	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0
10					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.9	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

2.2.2 For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area according to Figure 1-3.

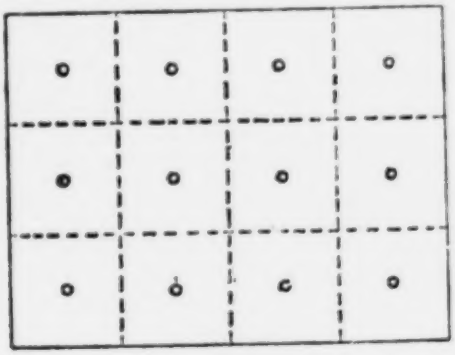


Figure 1-3. Cross section of rectangular stack divided into 12 equal areas, with traverse points at centroid of each area.

3. References

Determining Dust Concentration in a Gas Stream, ASME Performance Test Code #27, New York, N.Y., 1957.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, California, Bulletin WP-50, 1968.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pennsylvania, 1971, ASTM Designation D-2928-71.

Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

1. Principle and applicability

1.1 Principle. Stack gas velocity is determined from the gas density and from measurement of the velocity head using a Type S (Stauscheibe or reverse type) pitot tube.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards.

2. Apparatus

2.1 Pitot tube - Type S (Figure 2-1), or equivalent, with a coefficient within 5% over the working range.

2.2 Differential pressure gauge - Inclined manometer, or equivalent, to measure velocity head to within 10% of the minimum value.

2.3 Temperature gauge - Thermocouple or equivalent attached to the pitot tube to measure stack temperature to within 1.5% of the minimum absolute stack temperature.

2.4 Pressure gauge - Mercury-filled U-tube manometer, or equivalent, to measure stack pressure to within 0.1 in. Hg.

2.5 Barometer - To measure atmospheric pressure to within 0.1 in. Hg.

2.6 Gas analyzer - To analyze gas composition for determining molecular weight.

2.7 Pitot tube - Standard type, to calibrate Type S pitot tube.

3. Procedure

3.1 Set up the apparatus as shown in Figure 2-1. Make sure all connections are tight and leak free. Measure the velocity head and temperature at the traverse points specified by Method 1.

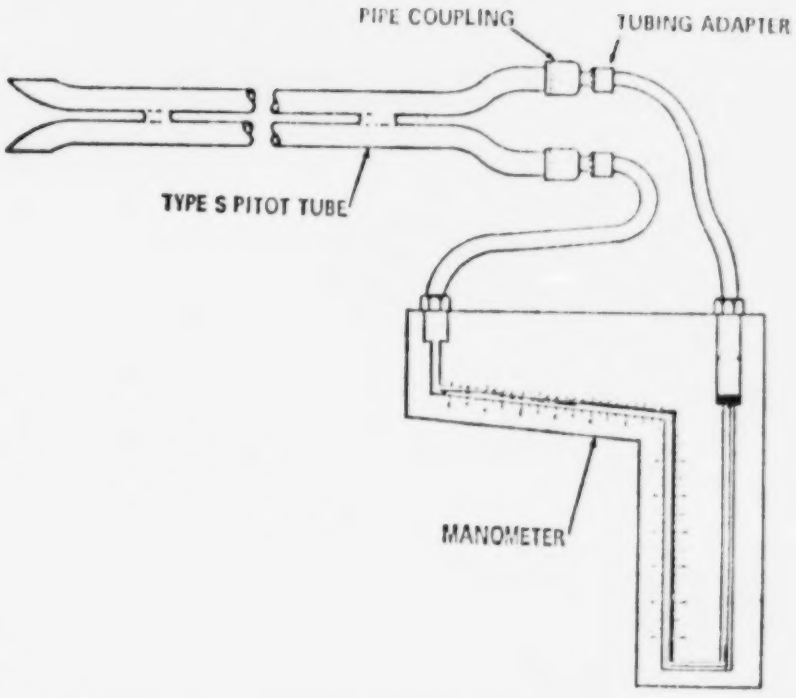


Figure 2-1. Pitot tube-manometer assembly.

3.2 Measure the static pressure in the stack.

3.3 Determine the stack gas molecular weight by gas analysis and appropriate calculations as indicated in Method 3.

4. Calibration

4.1 To calibrate the pitot tube, measure the velocity heat at some point in a flowing gas stream with both a Type S pitot tube and a standard type pitot tube with known coefficient. Calibration should be done in the laboratory and the velocity of the flowing gas stream should be varied over the normal working range. It is recommended that the calibration be repeated after use at each field site.

4.2 Calculate the pitot tube coefficient using equation 2-1.

$$C_{p_{test}} = C_{p_{std}} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}} \qquad \text{equation 2-1}$$

where:

$C_{p_{test}}$ = Pitot tube coefficient of Type S pitot tube.

$C_{p_{std}}$ = Pitot tube coefficient of standard type pitot tube (if unknown, use 0.99)

$\Delta_{p_{std}}$ = Velocity head measured by standard type pitot tube.

$\Delta_{p_{test}}$ = Velocity head measured by Type S pitot tube.

4.3 Compare the coefficients of the Type S pitot tube determined first with one leg and then the other pointed downstream. Use the pitot tube only if the two coefficients differ by no more than 0.01.

5. Calculations

Use equation 2-2 to calculate the stack gas velocity.

$$(V_s)_{avg.} = K_p C_p \left(\sqrt{\Delta p}\right)_{avg.} \sqrt{\frac{(T_s)_{avg.}}{P_s M_s}} \qquad \text{equation 2-2}$$

where:

$(V_s)_{avg.}$ = Stack gas velocity, feet per second (f.p.s.)

$K_p = 85.48 \frac{ft.}{sec.} \left(\frac{lb.}{lb.mole\text{-}^\circ R}\right)^{1/2}$ when these units are used.

C_p = Pitot tube coefficient, dimensionless.

$(T_s)_{avg.}$ = Average absolute stack gas temperature, °R.

$(\sqrt{\Delta p})_{avg.}$ = Average velocity head of stack gas, inches H_2O (see Figure 2-2).

P_s = Absolute velocity head of stack gas (wet basis), lb/lb-mole.

M_s = Molecular weight of stack gas (wet basis), lb./lb.-mole $M_d(1-B_{wo})+18B_{wo}$

M_d = Dry molecular weight of stack gas (from Method 3).

B_{wo} = Proportion by volume of water vapor in the gas stream (from Method 4).

Figure 2-2 shows a sample recording sheet for velocity traverse data. Use the averages in the last two columns of Figure 2-2 to determine the average stack gas velocity from Equation 2-2.

PLANT _____

DATE _____

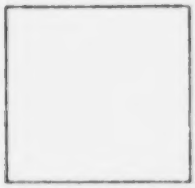
RUN NO _____

STACK DIAMETER, in _____

BAROMETRIC PRESSURE, in. Hg _____

STATIC PRESSURE IN STACK (P_g), in. Hg _____

OPERATORS _____



SCHEMATIC OF STACK CROSS SECTION

Traverse point number	Velocity head, in. H_2O	$\sqrt{\Delta_p}$	Stack Temperature (T_S), °F
AVERAGE:			

Figure 2-2. Velocity traverse data.

Use Equation 2-3 to calculate the stack gas volumetric flow rate.

$$Q_s = 3600\,(1 - B_{wo})V_s A \left(\frac{T_{std}}{(T_s)_{avg.}}\right)\left(\frac{P_s}{P_{std}}\right) \qquad \text{equation 2-3}$$

where:

Q_s = Volumetric flow rate, dry basis, standard conditions, ft.^{3}/hr.

A = Cross-sectional area of stack, ft^2

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6. References

Mark, L. S., Mechanical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1951.

Perry, J. H., Chemical Engineers' Handbook, McGraw-Hill Book Co., Inc., New York, N.Y., 1960.

Shigehara, R. T., W. F. Todd, and W. S. Smith, Significance of Errors in Stack Sampling Measurements. Paper presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, Missouri, June 14-19, 1970.

Standard Method for Sampling Stacks for Particulate Matter, In: 1971 Book of ASTM Standards, Part 23, Philadelphia, Pennsylvania, 1971, ASTM Designation D-2928-71.

Vennard J. D., Elementary Fluid Mechanics, John Wiley & Sons, Inc., New York, N.Y., 1947.

Method 3 - Gas Anaylsis for Carbon Dioxide, Excess Air, and Dry Molecular Weight

1. Principle and applicability

1.1 Principle. An integrated or grab gas sample is extracted from a sampling point and analyzed for its components using an Orsat analyzer.

1.2 Applicability. This method should be applied only when specified by the test procedures for determining compliance with the New Source Performance Standards. The test procedure will indicate whether a grab sample or an integrated sample is to be used.

2. Apparatus

2.1 Grab sample (Figure 3-1).

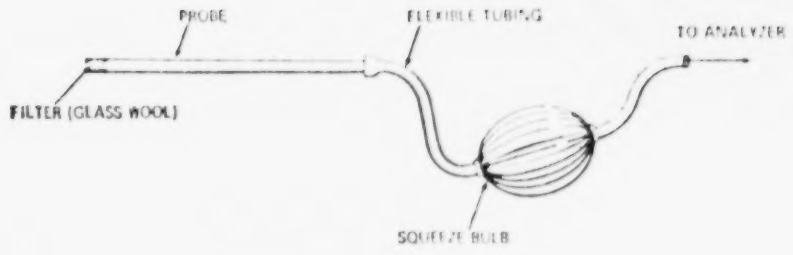


Figure 3-1. Grab-sampling train.

2.1.1 Probe - Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.1.2 Pump - One-way squeeze bulb, or equivalent, to transport gas sample to analyzer.

2.2 Integrated sample (Figure 3-2).

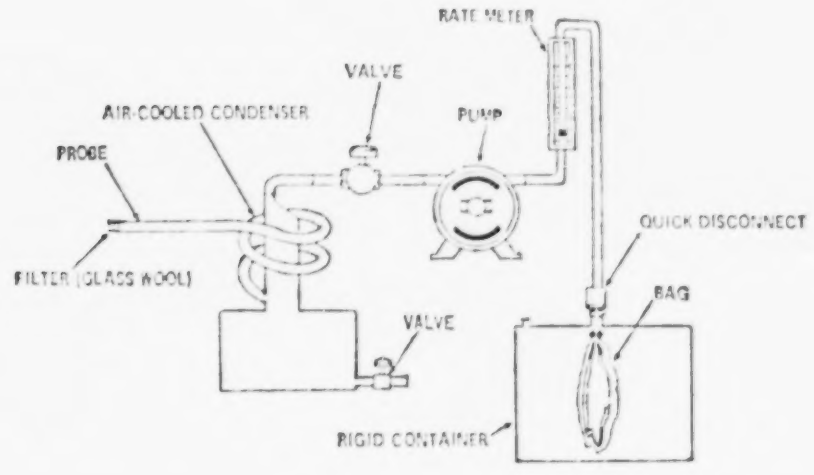


Figure 3-2. Integrated gas - sampling train.

2.2.1 Probe - Stainless steel or Pyrex[1] glass, equipped with a filter to remove particulate matter.

2.2.2 Air-cooled condenser or equivalent - To remove any excess moisture.

2.2.3 Needle valve - To adjust flow rate.

2.2.4 Pump - Leak-free, diaphragm type, or equivalent, to pull gas.

2.2.5 Rate meter - To measure a flow range from 0 to 0.035 cfm.

[1] Trade name.

2.2.6 Flexible bag - Tedlar,[1] or equivalent, with a capacity of 2 to 3 cu. ft. Leak test the bag in the laboratory before using.

2.2.7 Pitot tube - Type S, or equivalent, attached to the probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

2.3 Analysis

2.3.1 Orsat analyzer, or equivalent.

3. Procedure

3.1 Grab sampling

3.1.1 Set up the equipment as shown in Figure 3-1, making sure all connections are leak-free. Place the probe in the stack at a sampling point and purge the sampling line.

3.1.2 Draw sample into the analyzer.

3.2 Integrated Sampling

3.2.1 Evacuate the flexible bag. Set up the equipment as shown in Figure 3-2 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are tight and that there are no leaks.

3.2.2 Sample at a rate proportional to the stack velocity.

3.3 Analysis

3.3.1 Determine the CO_2, O_2, and CO concentrations as soon as possible. Make as many passes as are necessary to give constant readings. If more than ten passes are necessary, replace the absorbing solution.

3.3.2 For grab sampling, repeat the sampling and analysis until three consecutive samples vary no more than 0.5 percent by volume for each component being analyzed.

3.3.3 For integrated sampling, repeat the analyses of the sample until three consecutive analyses vary no more than 0.2 percent by volume for each component being analyzed.

4. Calculations

4.1 Carbon dioxide. Average the three consecutive runs and report the results to the nearest 0.1% CO_2.

4.2 Excess air. Use Equation 3-1 to calculate excess air, and average the runs. Report the result to the nearest 0.1% excess air.

$$\%EA = \frac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)} \times 100 \qquad \text{equation 3-1}$$

[1] Trade name.

where:

%EA = Percent excess air.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

%CO = Percent carbon monoxide by volume, dry basis.

0.264 = Ratio of oxygen to nitrogen in air by volume.

4.3 Dry molecular weight. Use Equation 3-2 to calculate dry molecular weight and average the runs. Report the result to the nearest tenth.

$$M_d = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%N_2 + \%\,CO) \qquad \text{equation 3-2}$$

where:

M_d = Dry molecular weight, lb./lb-mole.

$\%CO_2$ = Percent carbon dioxide by volume, dry basis.

$\%O_2$ = Percent oxygen by volume, dry basis.

$\%N_2$ = Percent nitrogen by volume, dry basis.

0.44 = Molecular weight of carbon dioxide divided by 100.

0.32 = Molecular weight of oxygen divided by 100.

0.28 = Molecular weight of nitrogen and CO divided by 100.

5. References

Altshuller, A. P., et al., Storage of Gases and Vapors in Plastic Bags, Int. J. Air & Water Pollution, 6:75-81, 1963.

Conner, William D., and J. S. Nader, Air Sampling with Plastic Bags, Journal of the American Industrial Hygiene Association, 25:291-297, May-June 1964.

Devorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Method 4 - Determination of Moisture in Stack Gases

1. Principle and applicability

1.1 Principle. Moisture is removed from the gas stream, condensed, and determined volumetrically.

1.2 Applicability. This method is applicable for the determination of moisture in stack gas only when specified by test procedures for determining compliance with New Source Performance Standards. This method does not apply when liquid droplets are present in the gas stream[1] and the moisture is subsequently used in the determination of stack gas molecular weight.

Other methods such as drying tubes, wet bulb-dry bulb techniques, and volumetric condensation techniques may be used.

2. Apparatus

2.1 Probe - Stainless steel or Pyrex[2] glass sufficiently heated to prevent condensation and equipped with a filter to remove particulate matter.

2.2 Impingers - Two midget impingers, each with 30 ml. capacity, or equivalent.

2.3 Ice bath container - To condense moisture in impingers.

2.4 Silica gel tube (optional) - To protect pump and dry gas meter.

2.5 Needle valve - To regulate gas flow rate.

2.6 Pump - Leak-free, diaphragm type, or equivalent, to pull gas through train.

2.7 Dry gas meter - To measure to within 1% of the total sample volume.

2.8 Rotameter - To measure a flow range from 0 to 0.1 c.f.m.

2.9 Graduated cylinder - 25 ml.

2.10 Barometer - Sufficient to read to within 0.1 inch Hg.

2.11 Pitot tube - Type S, or equivalent, attached to probe so that the sampling flow rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

---

[1] If liquid droplets are present in the gas stream, assume the stream to be saturated, determine the average stack gas temperature by traversing according to Method 1, and use a psychrometric chart to obtain an approximation of the moisture percentage.

[2] Trade name.

3. Procedure

3.1 Place exactly 5 ml. distilled water in each impinger. Assemble the apparatus without the probe as shown in Figure 4-1. Leak check by plugging the inlet to the first impinger and drawing a vacuum. Insure that flow through the dry gas meter is less than 1% of the sampling rate.

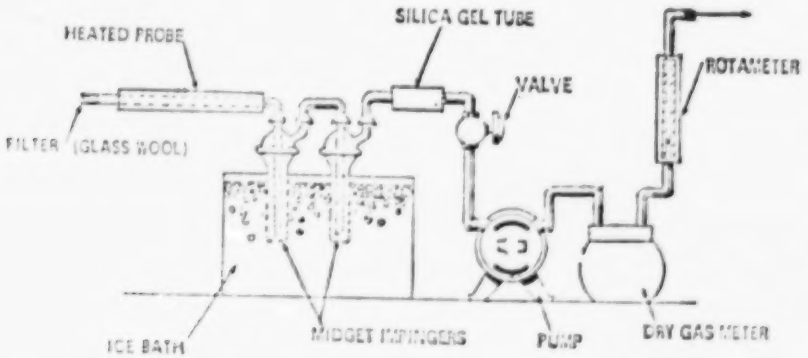


Figure 4-1. Moisture-sampling train.

3.2 Connect the probe and sample at a constant rate of 0.075 c.f.m. or at a rate proportional to the stack gas velocity. Continue sampling until the dry gas meter registers 1 cubic foot or until visible liquid droplets are carried over from the first impinger to the second. Record temperature, pressure, and dry gas meter readings as required by Figure 4-2.

LOCATION_____ COMMENTS

TEST_____

DATE_____

OPERATOR_____

BAROMETRIC PRESSURE_____

CLOCK TIME	GAS VOLUME THROUGH METER (Vm), ft^3	ROTAMETER SETTING ft^3/min	METER TEMPERATURE, °F

Figure 4-2. Field moisture determination.

3.3 After collecting the sample, measure the volume increase to the nearest 0.5 ml.

4. Calculations

4.1 Volume of water vapor collected.

$$V_{wc} = \frac{(V_f - V_i)\rho_{H_2O} RT_{std}}{P_{std} M_{H_2O}} = 0.0474 \frac{ft.^3}{ml.} (V_f - V_i) \qquad \text{equation 4-1}$$

where:

V_{wc} = Volume of water vapor collected (standard) conditions), cu.ft.

V_f = Final volume of impinger contents, ml.

V_i = Initial volume of impinger contents, ml.

R = Ideal gas constant, 21.83 inches Hg - cu.ft./lb.mole-°R.

P_{H_2O} = Density of water, 1 g./ml.

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

4.2 Gas volume.

$$V_{mc} = V_m \left(\frac{P_m}{P_{std}}\right) \left(\frac{T_{std}}{T_m}\right) = 17.71 \frac{°R}{in.\ Hg} \left(\frac{V_m P_m}{T_m}\right) \qquad \text{equation 4-2}$$

where:

V_{mc} = Dry gas volume through meter at standard conditions, cu.ft.

V_m = Dry gas volume measured by meter, cu.ft.

P_m = Barometric pressure at the dry gas meter, inches Hg.

P_{std} = Pressure at standard conditions, 29.92 inches Hg.

T_{std} = Absolute temperature at standard conditions, 530°R.

T_m = Absolute temperature at meter (°F+460), °R.

4.3 Moisture content.

$$B_{wo} = \frac{V_{wc}}{V_{wc} + V_{mc}} \quad \text{if } B_{wm} = \frac{V_{wc}}{V_{wc} + V_{mc}} + (0.025) \qquad \text{equation 4-3}$$

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

V_{wc} = Volume of water vapor collected (standard conditions), cu.ft.

V_{mc} = Dry gas volume through meter (standard conditions), cu.ft.

B_{wm} = Approximate volumetric proportion of water vapor in the gas stream leaving the impingers, 0.025.

5. References

Air Pollution Engineering Manual, Danielson, J. A. (ed.), U.S. DHEW, PHS, National Center for Air Pollution Control, Cincinnati, Ohio, PHS Publication No. 999-AP-40, 1967.

Levorkin, Howard, et al., Air Pollution Source Testing Manual, Air Pollution Control District, Los Angeles, California, November 1963.

Methods for Determination of Velocity, Volume, Dust and Mist Content of Gases, Western Precipitation Division of Joy Manufacturing Co., Los Angeles, California, Bulletin WP-50, 1968.

Method 5 - Determination of Particulate Emissions From Stationary Sources

1. Principle and applicability

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and its weight is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources only when specified by the test procedures for determining compliance with New Source Performance Standards.

2. Apparatus

2.1 Sampling train. The design specifications of the particulate sampling train used by EPA (Figure 5-1) are described in APTD-0581. Commercial models of this train are available.

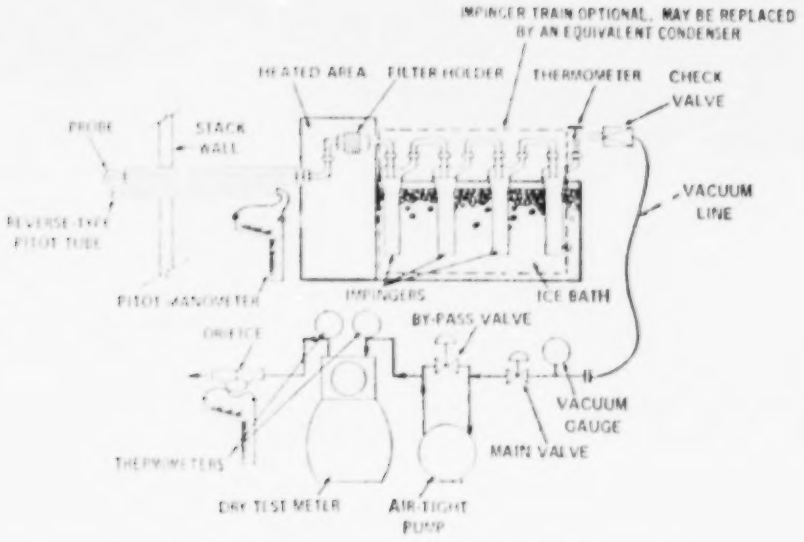


Figure 5-1. Particulate-sampling train.

2.1.1 Nozzle - Stainless steel (316) with sharp, tapered leading edge.

2.1.2 Probe - Pyrex[1] glass with a heating system capable of maintaining a minimum gas temperature of 250°F at the exit end during sampling to prevent condensation from occurring. When length limitations (greater than about 8 ft.) are encountered at temperatures less than 600°F, Incoloy 825[1], or equivalent, may be used. Probes for sampling gas streams at temperatures in excess of 600°F must have been approved by the Administrator.

2.1.3 Pitot tube - Type S, or equivalent, attached to probe to monitor stack gas velocity.

2.1.4 Filter holder - Pyrex[1] glass with heating system capable of maintaining minimum temperature of 225°F.

2.1.5 Impingers/Condenser - Four impingers connected in series with glass ball joint fittings. The first, third, and fourth impingers are of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch ID glass tube extending to one-half inch from the bottom of the flask. The second impinger is of the Greenburg-Smith design with the standard tip. A condenser may be used in place of the impingers provided that the moisture content of the stack gas can still be determined.

2.1.6 Metering system - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2% accuracy, and related equipment, or equivalent, as required to maintain an isokinetic sampling rate and to determine sample volume.

2.1.7 Barometer - To measure atmospheric pressure to ±0.1 inches Hg.

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[1] Trade name.

2.2 Sample recovery.
2.2.1 Probe brush - At least as long as probe.
2.2.2 Glass wash bottles - Two.
2.2.3 Glass sample storage containers.
2.2.4 Graduated cylinder - 250 ml.
2.3 Analysis.
2.3.1 Glass weighing dishes.
2.3.2 Desiccator.
2.3.3 Analytical balance - To measure to ±0.1 mg.

3. Reagents

3.1 Sampling
3.1.1 Filters - Glass fiber, MSA 1106 BH[1], or equivalent, numbered for identification and preweighed.
3.1.2 Silica gel - Indicating type, 6-16 mesh, dried at 175°C (350°F) for 2 hours.
3.1.3 Water.
3.1.4 Crushed ice.
3.2 Sample recovery.
3.2.1 Acetone - Reagent grade.
3.3 Analysis
3.3.1 Water.
3.3.2 Desiccant - Drierite,[1] indicating.

4. Procedure

4.1 Sampling
4.1.1 After selecting the sampling site and the minimum number of sampling points, determine the stack pressure, temperature, moisture, and range of velocity head.
4.1.2 Preparation of collection train. Weigh to the nearest gram approximately 200 g. of silica gel. Label a filter of proper diameter, desiccate[2] for at least 24 hours and weigh to the nearest 0.5 mg. in a room where the relative humidity is less than 50%. Place 100 ml. of water in each of the first two impingers, leave the third impinger empty, and place approximately 200 g. of preweighed silica gel in the fourth impinger. Set up the train without the probe as in Figure 5-1. Leak check the sampling train at the sampling site by plugging up the inlet to the filter holder and pulling a 15 in. Hg vacuum. A leakage rate not in excess of 0.02 c.f.m. at a vacuum of 15 in. Hg is acceptable. Attach the probe and adjust the heater to provide a gas temperature of about 250°F at the probe outlet. Turn on the filter heating system. Place crushed ice around the impingers. Add more ice during the run to keep the temperature of the gases leaving the last impinger as low as possible and preferably at 70°F or less. Temperatures above 70°F may result in damage to the dry gas meter from either moisture condensation or excessive heat.

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[1] Trade name.

[2] Dry using Drierite[1] at 70°F ±10°F.

4.1.3 Particulate train operation. For each run, record the data required on the example sheet shown in Figure 5-2. Take readings at each sampling point, at least every 5 minutes, and when significant changes in stack conditions necessitate additional adjustments in flow rate. To begin sampling, position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Sample for at least 5 minutes at each traverse point; sampling time must be the same for each point. Maintain isokinetic sampling throughout the sampling period. Nomographs are available which aid in the rapid adjustment of the sampling rate without other computations. APTD-0576 details the procedure for using these nomographs. Turn off the pump at the conclusion of each run and record the final readings. Remove the probe and nozzle from the stack and handle in accordance with the sampling recovery process described in section 4.2.

Figure 5-2. Particulate field data.

4.2 Sample recovery. Exercise care in moving the collection train from the test site to the sample recovery area to minimize the loss of collected sample or the gain of extraneous particulate matter. Set aside a portion of the acetone used in the sample recovery as a blank for analysis. Measure the volume of water from the first three impingers, then discard. Place the samples in containers as follows:

Container No. 1. Remove the filter from its holder, place in this container, and seal.

Container No. 2. Place loose particulate matter and acetone washings from all sample-exposed surfaces prior to the filter in this container and seal. Use a razor blade, brush, or rubber policeman to lose adhering particles.

Container No. 3. Transfer the silica gel from the fourth impinger to the original container and seal. Use a rubber policeman as an aid in removing silica gel from the impinger.

4.3 Analysis. Record the data required on the example sheet shown in Figure 5-3. Handle each sample container as follows:

PLANT _____

DATE _____

RUN NO. _____

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED, mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			
2			
TOTAL			

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME, ml	SILICA GEL WEIGHT, g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g*	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g ml):

$$\frac{\text{INCREASE, g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

Figure 5-3. Analytical data.

Container No. 1. Transfer the filter and any loose particulate matter from the sample container to a tared glass weighed dish, desiccate, and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 2. Transfer the acetone washings to a tared beaker and evaporate to dryness at ambient temperature and pressure. Desiccate and dry to a constant weight. Report results to the nearest 0.5 mg.

Container No. 3. Weigh the spent silica gel and report to the nearest gram.

5. Calibration

Use methods and equipment which have been approved by the Administrator to calibrate the orifice meter, pitot tube, dry gas meter, and probe heater. Recalibrate after each test series.

6. Calculations

6.1 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.2 Dry gas volume. Correct the sample volume measured by the dry gas meter to standard conditions (70°F, 29.92 inches Hg) by using Equation 5-1.

$$V_{m_{std}} = V_m \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right) = \left(17.71 \frac{R}{in.H_g}\right) V_m \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right) \quad \text{equation 5-1}$$

where:

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

V_m = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

T_{std} = Absolute temperature at standard conditions, 530°R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inches Hg.

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of mercury.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.3 Volume of water vapor.

$$V_{w_{std}} = V_{1_c}\left(\frac{\rho_{H_2O}}{M_{H_2O}}\right)\left(\frac{RT_{std}}{P_{std}}\right) = \left(0.0474\ \frac{\text{cu. ft.}}{\text{ml.}}\right) V_{1_c} \qquad \text{equation 5-2}$$

where:

$V_{w_{std}}$ = Volume of water vapor in the gas sample (standard conditions), cu. ft.

V_{1_c} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

R = Ideal gas constant, 21.83 inches Hg-cu. ft./lb.-mole-°R.

T_{std} = Absolute temperature at standard conditions, 530°R.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

6.4 Moisture content.

$$B_{wo} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}} \qquad \text{equation 5-3}$$

where:

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

$V_{w_{std}}$ = Volume of water in the gas sample (standard conditions) cu. ft.

$V_{m_{std}}$ = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

6.5 Total particulate weight. Determine the total particulate catch from the sum of the weights on the analysis data sheet (Figure 5-3).

6.6 Concentration.

6.6.1 Concentration in gr./s.c.f.

$$c'_s = \left(0.0154\ \frac{\text{gr.}}{\text{mg.}}\right)\left(\frac{M_n}{V_{m_{std}}}\right) \qquad \text{equation 5-4}$$

where:

c'_s = Concentration of particulate matter in stack gas, gr./s.c.f., dry basis.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.6.2 Concentration in lb./cu. ft.

$$c_s = \frac{\left(\frac{1}{453,600}\ \frac{lb.}{mg.}\right) M_n}{V_{m_{std}}} = 2.205 \times 10^{-6}\ \frac{M_n}{V_{m_{std}}}$$ equation 5-5

where:

C_a = Concentration of particulate matter in stack gas, lb./s.c.f., dry basis.

453,600 = Mg/lb.

M_n = Total amount of particulate matter collected, mg.

$V_{m_{std}}$ = Volume of gas sample through dry gas meter (standard conditions), cu. ft.

6.7 Isokinetic variation.

$$I = \frac{T_s\left[\frac{V_{l_c}(\rho_{H_2O})R}{M_{H_2O}} + \frac{V_m}{T_m}\left(P_{bar} + \frac{H}{13.6}\right)\right]}{V_s P_s A_n} X\ 100$$

$$= \frac{\left(1.667\ \frac{min.}{sec.}\right)\left[\left(0.00267\ \frac{in.\ Hg\text{-}cu.\ ft.}{ml.\ -\ ^\circ R}\right) V_{l_c} + \frac{V_m}{T_m}\left(P_{bar} + \frac{H}{13.6}\right)\right]}{V_s P_s A_n}$$ equation 5-6

where:

I = Percent of isokinetic sampling.

V_{l_c} = Total volume of liquid collected in impingers and silica gel (See Fig. 5-3), ml.

ρ_{H_2O} = Density of water, 1 g./ml.

R = Ideal gas constant, 21.83 inches Hg-cu. ft./lb. mole-°R.

M_{H_2O} = Molecular weight of water, 18 lb./lb.-mole.

V_m = Volume of gas sample through the gas meter (meter conditions), cu. ft.

T_m = Absolute average dry gas meter temperature (See Figure 5-2), °R.

P_{bar} = Barometric pressure at sampling site, inches Hg.

ΔH = Average pressure drop across the orifice (see Fig. 5-2), inches H_2O.

T_s = Absolute average stack gas temperature (see Fig. 5-2), °R.

θ = Total sampling time, min.

V_s = Stack gas velocity calculated by Method 2, Equation 2.2, ft./sec.

P_s = Absolute stack gas pressure, inches Hg.

A_n = Cross-sectional area of nozzle, sq. ft.

6.8 Acceptable results. The following range sets the limit on acceptable isokinetic sampling results:

If $90\% \leq I \leq 110\%$, the results are acceptable, otherwise, reject the results and repeat the test.

7. Reference.

Addendum to Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, Dec. 6, 1967.

Martin, Robert M., Construction Details of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0581.

Rom, Jerome J., Maintenance, Calibration, and Operation of Isokinetic Source Sampling Equipment, Environmental Protection Agency, APTD-0576.

Smith, W. S., R.T. Shigehara, and W. F. Todd, A Method of Interpreting Stack Sampling Data, Paper presented at the 63rd Annual Meeting of the Air Pollution Control Association, St. Louis, Mo., June 14-19, 1970.

Smith, W. S., et.al., Stack Gas Sampling Improved and Simplified with New Equipment, APCA paper No. 67-119, 1967.

Specifications for Incinerator Testing at Federal Facilities, PHS, NCAPC, 1967.

APPENDIX B

SUGGESTED CONTENTS OF STACK TEST REPORTS

CONTENTS OF STACK TEST REPORTS

In order to adequately assess the accuracy of any test report the basic information listed in the following suggested outline is necessary:

1. Introduction. Background information pertinent to the test is presented in this section. This information shall include, but not be limited to, the following:

   a. Manufacturer's name and address.

   b. Name and address of testing organization.

   c. Names of persons present, dates and location of test.

   d. Schematic drawings of the process being tested showing emission points, sampling sites, and stack cross section with the sampling points labeled and dimensions indicated.

2. Summary. This section shall present a summary of test findings pertinent to the evaluation of the process with respect to the applicable emission standard. The information shall include, but not be limited to, the following:

   a. A summary of emission rates found.

   b. Isokinetic sampling rates achieved if applicable.

   c. The operating level of the process while the tests were conducted.

3. Procedure. This section shall describe the procedures used and the operation of the sampling train and process during the tests. The information shall include, but not be limited to, the following:

   a. A schematic drawing of the sampling devices used with each component designated and explained in a legend.

   b. A brief description of the method used to operate the sampling train and procedure used to recover samples.

4. Analytical Technique. This section shall contain a brief description of all analytical techniques used to determine the emissions from the source.

5. Data and Calculations. This section shall include all data collected and calculations. As a minimum, this section shall contain the following information:

   a. All field data collected on raw data sheets.

   b. A log of process and sampling train operations.

   c. Laboratory data including blanks, tare weights, and results of analysis.

   d. All emission calculations.

6. Chain of Custody. A listing of the chain of custody of the emission test samples.

7. Appendix:

   a. Calibration work sheets for sampling equipment.

   b. Calibration or process logs of process parameters.

APPENDIX C

VISIBLE EMISSION OBSERVATION FORM

RECORD OF VISUAL DETERMINATION OF OPACITY

PAGE___of___

COMPANY_____
LOCATION_____
TEST NUMBER_____
DATE_____
TYPE FACILITY_____
CONTROL DEVICE_____

HOURS OF OBSERVATION_____
OBSERVER_____
OBSERVER CERTIFICATION DATE_____
OBSERVER AFFILIATION_____
POINT OF EMISSIONS_____
HEIGHT OF DISCHARGE POINT_____

	Initial			Final
CLOCK TIME				
OBSERVER LOCATION Distance to Discharge				
Direction from Discharge				
Height of Observation Point				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start--End	Sum	Average

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time evaluation was made.

OBSERVATION RECORD PAGE ___ OF ___

COMPANY _____
LOCATION _____
TEST NUMBER _____
DATE _____

OBSERVER _____
TYPE FACILITY _____
POINT OF EMISSIONS _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	0							
	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
	11							
	12							
	13							
	14							
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	23							
	24							
	25							
	26							
	27							
	28							
	29							

OBSERVATION RECORD PAGE ___ OF ___

COMPANY _____
LOCATION _____
TEST NUMBER _____
DATE _____

OBSERVER _____
TYPE FACILITY _____
POINT OF EMISSIONS _____

Hr.	Min.	Seconds 0	15	30	45	STEAM PLUME (check if applicable) Attached	Detached	COMMENTS
	30							
	31							
	32							
	33							
	34							
	35							
	36							
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	60							

[FR Doc 74-26150 Filed 11-11-74;8:45 am.]